Weichselian climate change and impact on aeolian and fluvial periglacial environments in the Twente area, Lutterzand type locality. Excursion Guide INTIMATE COST workshop De Lutte, The Netherlands, 28 march 2012

Kasse, C.

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C. Kasse
Faculty of Earth and Life Sciences
Vrije Universiteit
Amsterdam

Outline of the Weichselian depositional history in the Dinkel valley

after J. Van Huissteden 1991 In: Excursion guide Symposium Periglacial Environments in Relation to Climatic Change.

In the Twente region basins and ridges of glacial origin occur, dating from the Saalian glaciation (MIS 6). During the Eemian and Weichselian this relief has been levelled by erosion of higher parts of the landscape, and sedimentation in basins and valleys. The basin deposits provide a record of the post-Saalian climatic and geomorphological history. This sediment sequence consists of a series of sand, silt, and peat beds of generally fluvial origin. Most of this basin fill appears to be of Weichselian Pleniglacial age. These sediments have been deposited by rivers and wind in a lowland tundra landscape. In the Dinkel valley Weichselian age deposits (Boxtel Formation) may reach a thickness of more than 25 m.

Fluvial deposits of Eemian and Early Weichselian age (MIS 5) consist of sand, clay and peat beds. The deposits do not differ much in aspect, and appear to be laid down by river systems with extensive wet floodplains. A major discontinuity between the Eemian and Weichselian appears to be absent.

The Pleniglacial sequence starts with a major fluvial down-cutting phase (MIS 4). Residual gravel beds and aeolian deposits overlie the Early Weichselian deposits, and gravel-rich channel deposits have been found also. The thin gravel beds overlie ice-wedge casts dating from the Early Pleniglacial stadial.

More detail is known from the Middle Pleniglacial deposits (MIS 3). These consist mainly of fluvially deposited sand beds, silts, clay, peat and gyttja. In general, the deposits are characterized by high lateral variability. Exposures reveal the importance of flood basin environments, while channel deposits are of relatively minor extent. Many sand beds appear to be crevasse splay deposits, which interrupt silt and peat in flood basin environments. It is supposed that most of the Middle Pleniglacial sequence in the Dinkel valley and the Hengelo basin has been deposited by an anastomosing river system with well developed flood basins and extensive crevasse splays. During periods of low river activity vegetation could develop on the flood plains. Crevasse splays, due to increased river activity, brought an end to this vegetation growth. Grain-size analysis shows evidence of an aeolian component in the sediment. Especially silts contain a loess component. In general however, preservation of true aeolian deposits has been restricted strongly by frequent fluvial reworking. Middle Pleniglacial sands of possible (fluvio-)aeolian origin occur mainly on the eastern margin of the Dinkel valley. This indicates predominantly (north-) westerly wind directions during the Middle Pleniglacial.

Three erosion levels occur within the Middle Pleniglacial deposits in the Dinkel valley, aged approximately > 47,000 BP, ca. 38 - 40,000 BP and 32 - 34,000 ^{14}C BP. Two of these may be local phenomena, but the second erosion level appears to occur outside the Dinkel valley as well. In the Hengelo basin, it is associated with periglacial phenomena (ice-wedge casts) which point to the temporary presence and subsequent degradation of permafrost. The ice-wedge casts occur in silty material only. This indicates mean annual temperatures between -4.5 and -6 °C at that time (approximately 40,000 - 39,000 BP). The ensuing permafrost degradation has led to the development of thaw lakes, of which the deposits have been found in an exposure near Hengelo (Van Huissteden, 1990; Ran et al., 1990).

The Upper Pleniglacial deposits (MIS 2) are in many respects different from those of the Middle Pleniglacial. Often an erosional transition is present between the two units, combined with a change in colour, organic matter content, lime content and grain size. The sequence consists of coarse fluvial sands, interfingering with silty, fluvially reworked aeolian sands, which are more abundant near the top of the unit. Peat beds are lacking, well-developed silt beds are rare (Van Huissteden et al. 1986; Vandenberghe & Van Huissteden, 1988). The coarse fluvial sands exhibit sedimentary structures pointing to a fluvial channel origin, such as cross-bedding and cross-lamination. Exposure data indicate channels of high width-depth ratio. The silty aeolian sands are interpreted as an overbank facies of the river. In this overbank environment aeolian sedimentation alternates with surficial fluvial reworking by overbank flooding: fluvio-eolian sands (Older Coversands I) (Van der Hammen & Wijmstra, 1971; Van Huissteden & Vandenberghe, 1989; Van Huissteden et al., 2000).

Within the Upper Pleniglacial fluvial and fluvio-aeolian deposits ice-wedge casts are of frequent occurrence. The top of the member is often marked by large cryoturbations, truncated by a gravel bed (Beuningen gravel bed). The Beuningen gravel bed marks the disappearance of permafrost from the sequence.

The Late Pleniglacial fluvio-aeolian sand and Beuningen Gravel Bed are overlain by a mantle of aeolian sands ('Coversands'), belonging to the Lutterzand Member and Wierden Member. The Lutterzand Member (Older Coversand II of Van der Hammen & Wijmstra, 1971) dates from the Upper Pleniglacial and early Late Glacial, and it forms an almost continuous cover in the Dinkel valley. The top surface displays a very gentle undulating relief; locally more marked ridges may occur. Its overall presence, including the centre of the valley, points to a strong reduction of fluvial activity. Structures which indicate the presence of permafrost are absent in these sands (Van Huissteden et al., 2001).

The Wierden Member (MIS 1) consists of local aeolian sand deposits (Younger Coversands I and II), in which silt and peat beds dating from the Bølling (Lower Loamy Bed) and Allerød (Usselo Soil or Bed) Interstadials occur. Fluvial activity has resumed during the Late Glacial, with the creation of deep fluvial incisions. At the same time dune formation may have led to damming of river courses locally. During the Late Glacial and Holocene the fluvial incisions have been filled in with sands, peat, gyttja and clay. Medieval land degradation has led to subrecent dune formation locally in the Lutterzand area.

The Lutterzand exposure

The Lutterzand exposure is a natural exposure along the Dinkel river (fig. 1). Its lithostratigraphy has been described extensively in Van der Hammen & Wijmstra (1971), and has served as a type site for the Late Weichselian stratigraphy of northwestern Europe (fig. 2). Several sequences have been restudied and dated in detail (Bateman & Van Huissteden, 1999; Derese, 2011 see enclosed copy). The sequence is dominated by Upper Pleniglacial and Late Glacial deposits. Locally, intercalated soils, peat and silt beds dating from the Late Glacial Bølling (Lower Loamy Bed) and Allerød (Usselo Soil or Bed) Interstadials are found. Also Late Holocene dune sands are exposed.

At the first site in this exposure (fig. 3), a sequence of aeolian sands of Upper Pleniglacial to Holocene age is exposed. At the base, the lower part of the Lutterzand Member shows traces of fluvial reworking, which are otherwise rare within this unit. At the top of the Pleniglacial deposits, a soil or peat of Allerød age (Usselo Soil), is found (fig. 2 pollen diagram). This soil/peat is covered by dune sands (Younger Coversands II) dating from the Late Dryas stadial, in which a Holocene podzol soil has been developed. At the highest point Holocene dune sands are found.

The next site (fig. 4) is an exposure showing fluvial and aeolian deposits from Upper Pleniglacial age. Most of the sequence consists of medium, cross-bedded fluvial sand, interfingering with finer, silty aeolian deposits. The aeolian deposits show evidence of fluvial reworking (fluvio-aeolian sand) by their grain-size distribution and sedimentary structures. Often the silty sands show a typical pattern of subvertical joints possibly related to former permafrost conditions. In the upper part, these sediments are strongly disturbed by several generations of large cryoturbations related to degradation of permafrost. The cryoturbations have been truncated by the Beuningen Gravel Bed which is not affected by cryoturbation. This bed shows gravelly gully fills and a desert pavement, which suggest a polygenetic origin with sheet flow conditions and deflation under polar desert conditions.

At the last site (fig. 5), the complete sequence from Upper Pleniglacial deposits to Holocene dune sands is present again. In the Late Glacial aeolian sands a, locally cryoturbated, silt bed (Lower Loamy Bed) of Bølling age is found overlain by a bioturbated soil of Allerød age (Usselo Soil).

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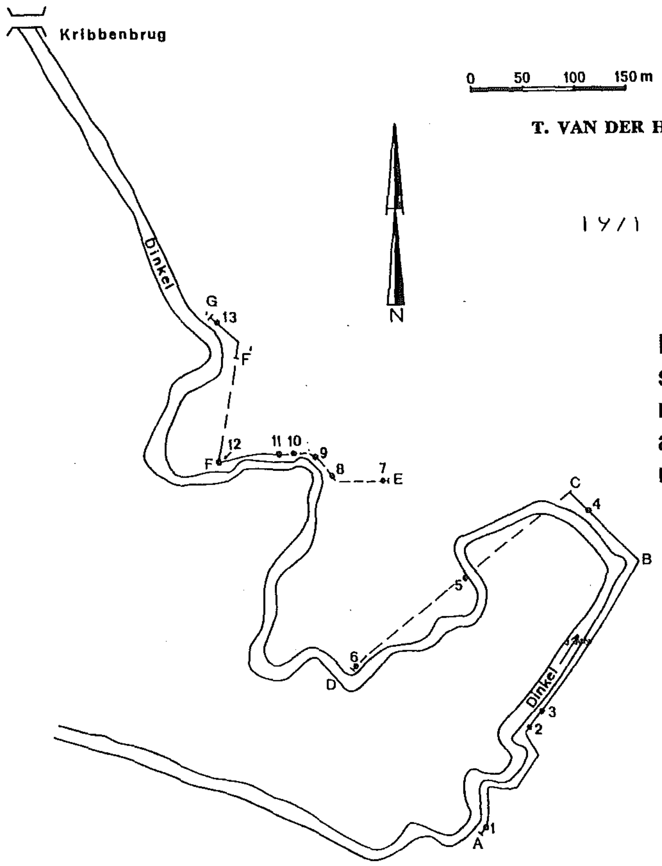
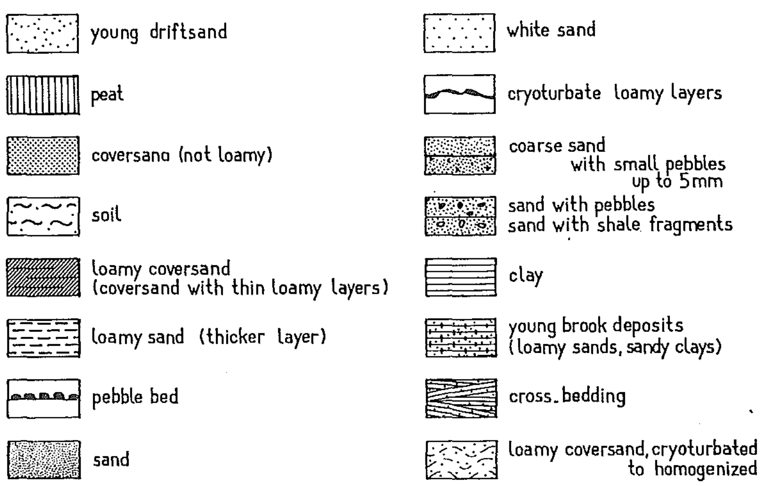


Fig. 1. Location of sections along the Dinkel river in the Lutterzand area (letters and ciphers refer to the sections)



Legend of the lithology of the sections

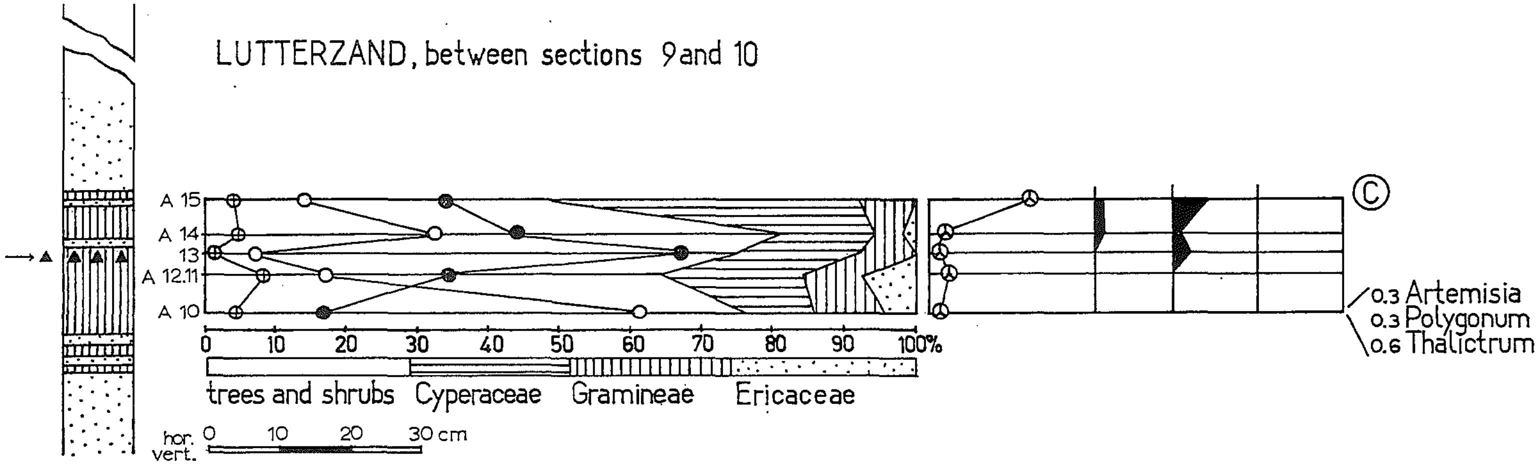


FIG. — Pollen diagrams of Allerød Interstadial (c) and Holocene (d and e) of the profile Lutterzand E–F, sections 9–11 (see figs. 14 and 22). Legend see fig. 24

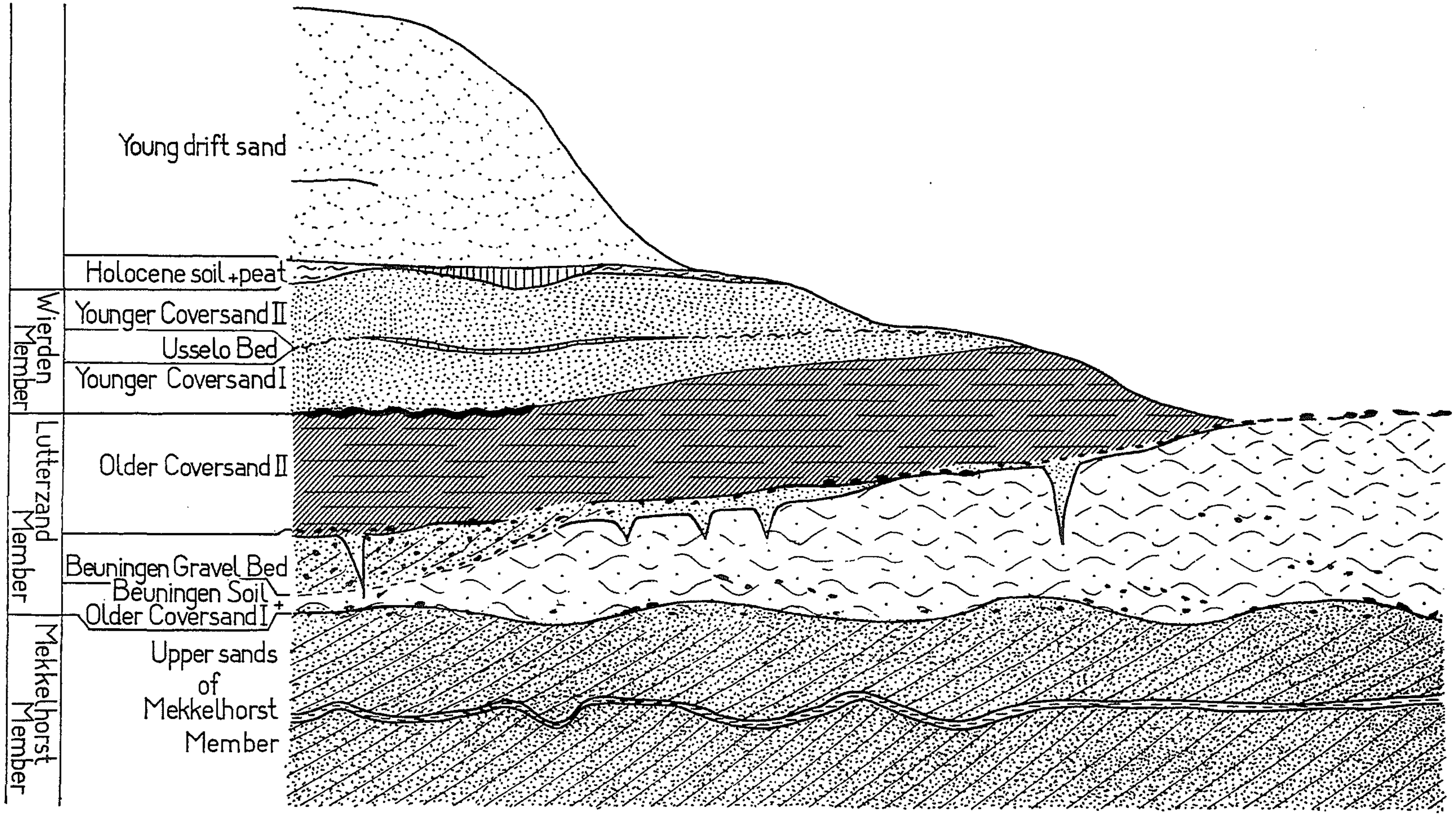


Fig. 2 — Diagrammatic section of the Lutterzand area

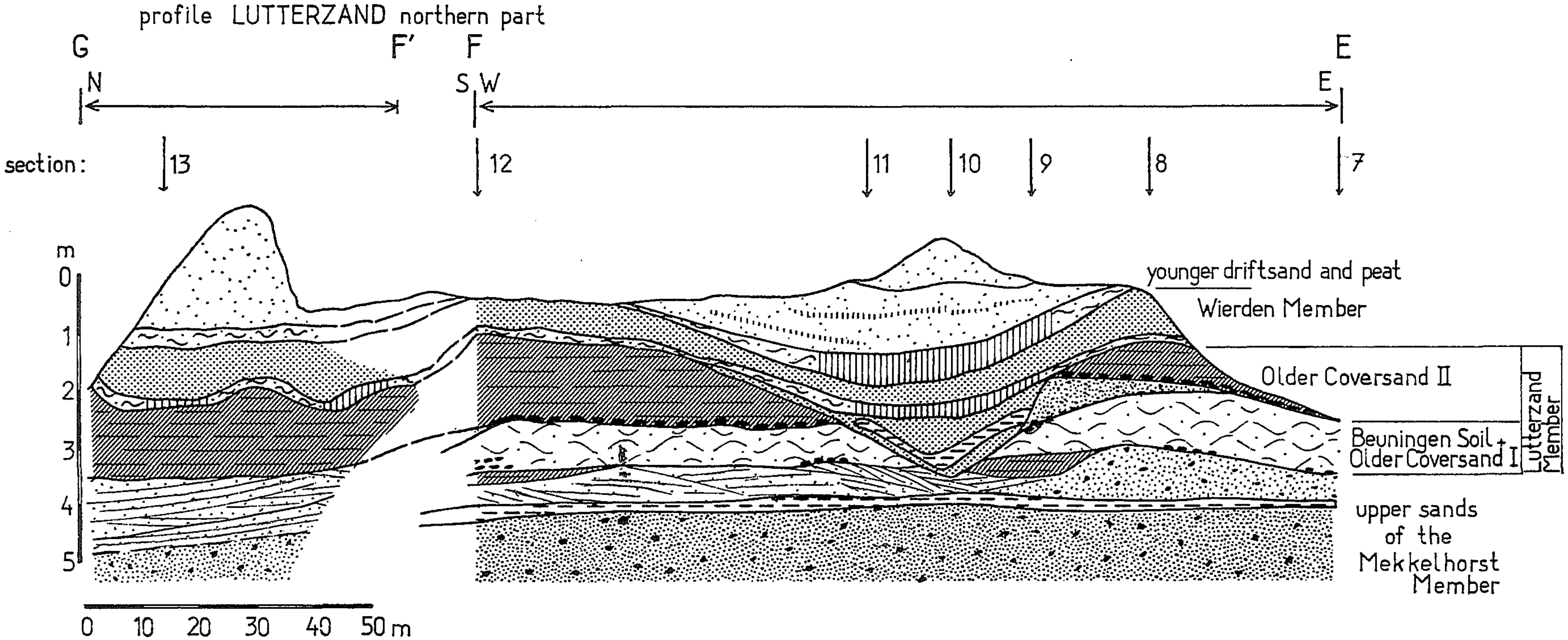


FIG. 3 — General profile of northern part of the Lutterzand exposures (E–F–G; see fig. 12)
(survey by Mrs. E. J. SCHREVE-BRINKMAN)

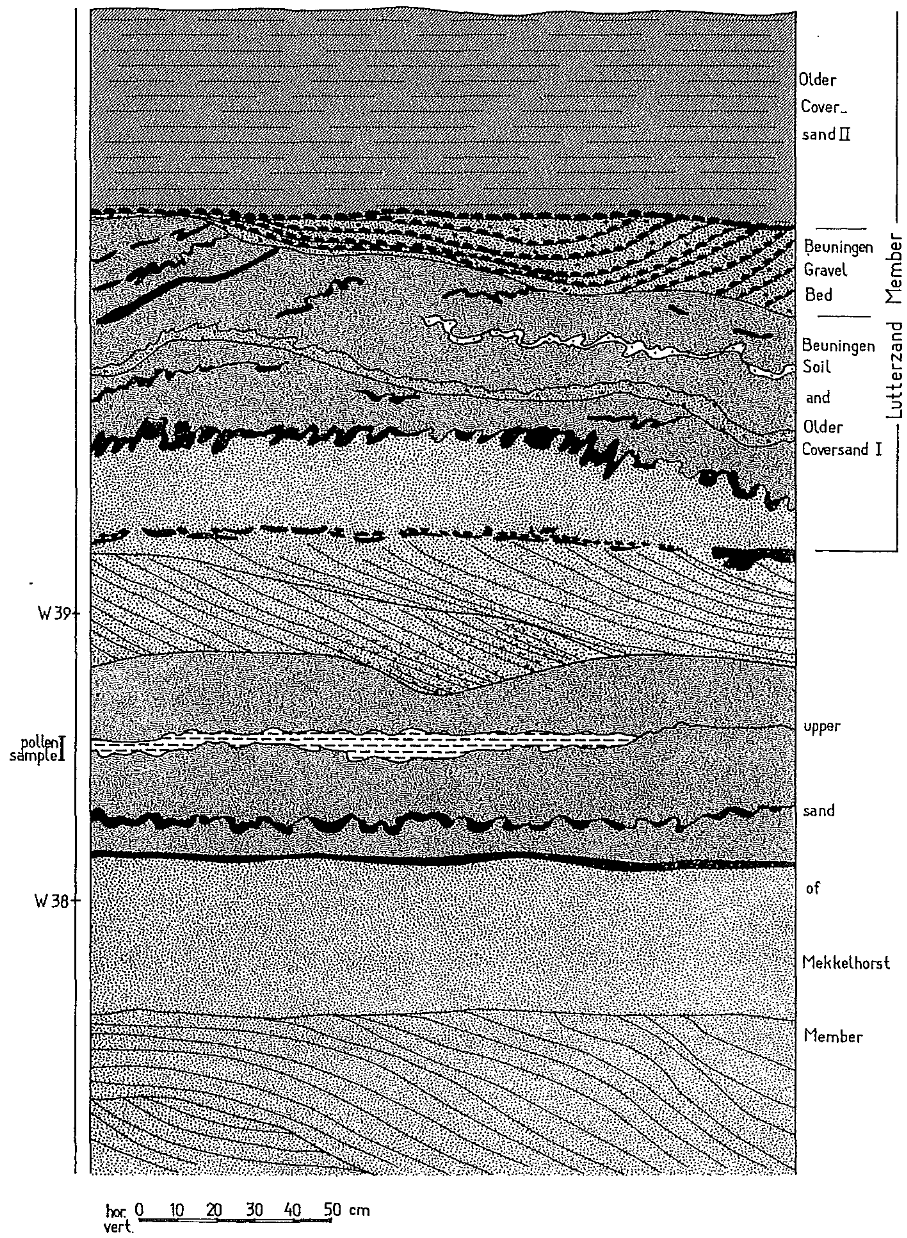


FIG. 4 — Detail of profile C–D, Lutterzand, section 5 (see figs. 12 and 13) (survey by T. A. WIJMSTRA)

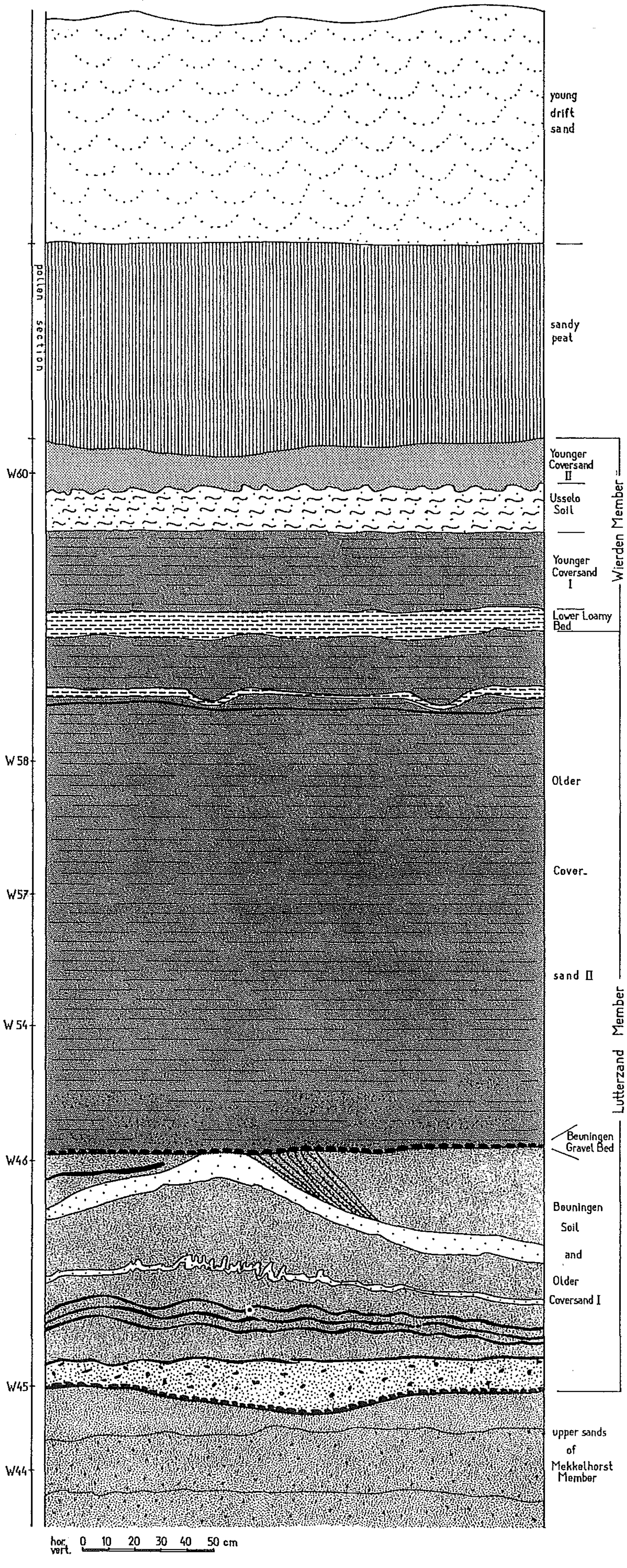


FIG. 5 — Detail of profile A–B, Lutterzand, section 1 (see figs. 12 and 13) (survey by T. A. WIJMSTRA)